

COMPLETED

Distributional Consequences of Natural Gas Decontrol

**Appendix D to "A Study of Alternatives to the
Natural Gas Policy Act of 1978"**

November 1981

U.S. Department of Energy

Office of Policy, Planning and Analysis
Division of Energy Deregulation



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I. INTRODUCTION

This appendix supplements the discussion of the distribution of the costs and benefits of decontrol that appears in "A Study of Alternatives to the Natural Gas Policy Act of 1978." It provides detailed estimates of the effect each of three decontrol policies would have on the gas expenditures of families living in houses heated with gas, the method used to estimate the expenditures, and the method used to estimate changes in producer income.

Although this appendix discusses increases in the costs of residential gas users and the income of gas producers, the reader should not infer that these are the only effects of decontrol. Two key findings of the study of alternatives to the NGPA are that current policies have hidden costs and that on balance the benefits of both phased and full decontrol exceed the costs. These findings are discussed in the study itself and in other appendices to the study. This appendix covers only two aspects of the full array of costs and benefits--increased gas costs to households and increased producer income.

The three policies considered in the discussion of the gas expenditures of households are current policies, full decontrol in 1982, and a phased decontrol policy, called the "New-New" policy. Current policies provide for gradual increases in the price of gas at the wellhead from now until the end of 1984 and for the removal of wellhead price controls on certain categories of gas in 1985 and 1987. The full and immediate decontrol alternative would provide for the removal of wellhead price controls on all gas on January 1, 1982. The "New-New" phased decontrol alternative would allow the price of gas from wells drilled after January 1, 1982, called "New-New" gas, to rise to an oil-related price and the price of all other categories of gas to reach the oil-related price by 1985. All wellhead price controls would be removed in 1985.

The discussion is in six sections. Section II describes the effect full decontrol would have on the gas expenditures of households that heat with gas. Section III provides a similar analysis of the effects of the "New-New" phased decontrol option.^{1/} Section IV describes the method used to estimate residential gas bills of households in several economic and demographic groups. Section V describes the method used to estimate the amount of low income energy assistance that would be available to low income families that live in houses heated

^{1/} A detailed discussion of these options appears in the main report of the natural gas decontrol study.

with gas. Section VI discusses the method used to compare the costs of heating with fuel oil, electricity, and natural gas. Section VII describes the method used to estimate the changes in the taxes and after-tax income of producers and royalty owners reported in the study of alternatives to the NGPA.

II. EFFECTS OF FULL DECONTROL ON THE GAS EXPENDITURES OF HOUSEHOLDS WITH GAS HEAT

This section provides estimates under the current policy and full decontrol cases of (1) the expenditures for gas of residents of gas-heated houses in several demographic and economic groups (2) the expenditures for gas of poor families and the benefits poor families would receive from the Low Income Energy Assistance Program, and (3) the costs of heating with gas, fuel oil, and electricity in selected regions of the United States. The estimates of costs show wide variation among demographic and economic groups, but are still averages that conceal additional variation. The costs of individual households are expected to vary widely from the group averages.^{1/}

A. Effects of Full Decontrol in 1982 on the Bills of Gas Heated Households

If full decontrol occurs in 1982, the average annual gas bill of a family living in a house heated with gas is estimated to rise from \$460 in 1981 to \$620 in 1982.^{2/} The average annual bill is estimated to continue to rise slightly in subsequent years, to \$630 in 1983, \$640 in 1984, and \$690 in 1985. These estimates take account of efforts by consumers to conserve gas

^{1/} All estimates in this analysis for the a.d.-range assumptions of gas supply and demand. Because of difficulties of estimation, the estimates of residential costs do not include the costs of conservation investments to reduce expenditures for gas or the cost of turning down the thermostat.

^{2/} All estimates in this appendix are in constant 1980 dollars unless otherwise noted.

The method of estimating residential costs is described in Section IV.

in response to rising prices. Under current policies, the average annual bill is projected to rise gradually from \$460 in 1981 to \$480 in 1982, \$500 in 1983, and \$520 in 1984. Then, a sharp increase to \$690 would take place in 1985. In 1982, full decontrol would cause the average annual bill to be \$140 higher than under current policies. The annual differences would shrink until 1985, when there would be little difference between bills under the two policies. (See Table 1.)

The effect that full decontrol would have on the average annual gas bills of families living in houses heated with gas varies considerably by demographic and economic group. A major factor affecting the increase in the gas bill is the region in which the household is located because regions differ in climate, characteristics of the housing stock, and the costs of transporting gas. (A map of the four regions studied appears in Figure 1.)

Because of full decontrol, residential prices in 1982 are projected to increase in real terms by 34% in the North East, 42% in the North Central states, 45% in the South, and 47% in the West. Gas bills would not increase as much as prices because price increases are expected to lead residential consumers to reduce their average gas consumption by about 8% in 1982. After conservation residential gas bills are estimated to rise \$160 (or 25%) in the North East, \$180 (or 31%) in the North Central states, \$120 (or 35%) in the South, and \$100 (or 33%) in the West. (The gas bills under current policy and the increase from decontrol for different demographic and economic groups appear in Tables 1, 2, and 3.)

Size of residence is another major factor that affects the size gas expenditures. Taking account of size and location, annual bills in 1982 under current policies are expected to range from an average of \$230 for 1 to 5 room houses in the West to \$810 for houses with 6 or more rooms in the North East. Increases from decontrol are likely to be \$90 and \$200 respectively.

The average gas bills of renters are lower than the average gas bills of home owners.^{1/} The annual gas bill under current policies in 1982 is estimated to average \$390 for rented residences and \$530 for owner-occupied residences. With full decontrol, the bills are estimated to increase by \$110 and \$160 respectively. Although home owners would bear the full

^{1/} This is not say that, with all other things equal, renters consume less energy than home owners. The gas bills of renters are likely to be lower than those of home owners because of differences in size of residence and other factors.

Figure 1

CENSUS REGIONS

Table 1

COMPARISON OF RESIDENTIAL NATURAL GAS BILLS UNDER
CURRENT POLICY AND FULL DECONTROL, 1981-1985
(1980 dollars)^{1/}

<u>POLICY AND REGION</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>
<u>FULL DECONTROL IN 1982</u>					
North East	620*	800*	810*	820*	870*
North Central	560	770	780	800	860
South	330	460	460	470	520
West	280	400	410	420	450
Average U.S.	460	620	630	640	690
<u>CURRENT POLICY</u>					
North East	620*	640*	670*	690*	860*
North Central	560	590	620	650	850
South	330	340	350	360	520
West	280	300	320	330	450
Average U.S.	460	480	500	520	690
<u>DIFFERENCE BETWEEN POLICIES</u>					
North East	-	+160*	+140*	+130*	+ 10*
North Central	-	+180	+160	+150	+ 10
South	-	+120	+110	+110	-
West	-	+100	+ 90	+ 90	-
Average U.S.	-	+140	+130	+120	-

^{1/} The estimates in this table are based on data from (1) the Two-Market Model described in Appendix A, (2) the Residential Energy Consumption Survey (1979-1980), and (3) the American Gas Association. (See section IV below, for a description of the method used to estimate costs.)

Since the gas market model is not a probabilistic model and since the regional prices were not probabilistically estimated, confidence intervals for the average costs cannot be calculated. However, the accuracy of the estimates of the relative average expenditures of the groups reported will be affected mostly by sampling error in the Residential Energy Consumption Survey. The 95% confidence interval for the average consumption in 1979-1980 of each group reported in this table is less than plus or minus 10% unless noted.

* The range of the 95% confidence interval of gas consumption estimated in RECS is between $\pm 10\%$ and $\pm 20\%$.

Table 2

NATIONAL AVERAGE GAS COSTS OF GAS-HEATED HOUSEHOLDS
IN 1982 UNDER CURRENT POLICY AND FULL DECONTROL
(1980 dollars)^{1/}

Group	Gas-Heated Households		Average Residential Gas Costs	
	Number (millions)	% of ALL Households	Under Current Policy	Increase from Full Decontrol in 1982
<u>Region</u>				
North East	7.6	9.2	640*	160*
North Central	17.0	20.6	590	180
South	10.0	12.1	340	120
West	10.6	12.9	300	100
<u>Ownership Status^{2/}</u>				
Own	29.7	36.0	530	160
Rent	15.0	18.2	390	110
<u>Number of Rooms</u>				
1 - 5	24.6	29.8	390	120
6 or more	20.5	24.8	580	170
<u>Poverty Status^{3/}</u>				
Below 125%	7.9	9.5	420	120
Above 125%	37.3	45.2	490	150
<u>Age</u>				
Under 60	32.7	39.6	490	140
60 and over	12.5	15.1	450	140
TOTAL	45.1	54.7	480	140

^{1/} See note to Table 1.

The 95% confidence interval for the average consumption in 1979-1980 of each group reported in this table is less than plus or minus 10% unless noted.

* The range of the 95% confidence interval of average gas consumption in 1979-1980 is between $\pm 10\%$ and $\pm 20\%$.

The number and percentage of households in some categories do not add to the total because of rounding.

^{2/} The ownership status categories do not add to the total because rent-free residences are omitted.

^{3/} Below 125% refers to households below 125% of the poverty level. Above 125% refers to all households above 125% of the poverty level.

Table 3

REGIONAL AVERAGE GAS COSTS OF GAS-HEATED HOUSEHOLDS IN 1982
 UNDER CURRENT POLICY AND FULL DECONTROL
 (1980 dollars)^{1/}

Group	North East				North Central			
	Gas-Heated Households		Average Residential Gas Cost		Gas-Heated Households		Average Residential Gas Cost	
	Number (millions)	% of ALL Households	Under Current Policy	Increase from Full Decontrol in 1982	Number (millions)	% of ALL Households	Under Current Policy	Increase from Full Decontrol in 1982
<u>Ownership Status</u>								
Own	4.5	5.4	750	190	12.2	14.8	620	200
Rent	3.1	3.7	490**	130**	4.7	5.7	500	160
<u>Number of Rooms</u>								
1 - 5	4.0	4.9	490*	130*	9.2	11.1	510	150
6 or more	3.5	4.3	810*	200*	7.9	9.5	690	210
<u>Poverty Status</u>								
Below 125%	1.1	1.3	590*	150*	2.8	3.4	530*	170*
Above 125%	6.5	7.9	650	160	14.3	17.3	600	190
<u>Age</u>								
Under 60	5.7	7.0	640	160	12.5	15.1	590	190
60 and over	1.8	2.2	640*	160*	4.6	5.5	590*	180*
TOTAL	7.6	9.2	640*	160*	17.0	20.6	590	180

Table 3 (continued)

REGIONAL AVERAGE GAS COSTS OF GAS-HEATED HOUSEHOLDS IN 1982
 UNDER CURRENT POLICY AND FULL DECONTROL
 (1980 dollars)^{1/}

Group	South				West			
	Gas-Heated Households		Average Residential Gas Cost		Gas-Heated Households		Average Residential Gas Cost	
	Number (millions)	% of ALL Households	Under Current Policy	Increase from Full Decontrol in 1982	Number (millions)	% of ALL Households	Under Current Policy	Increase from Full Decontrol in 1982
<u>Ownership Status</u>								
Own	6.8	8.3	370*	120*	6.3	7.6	340*	110*
Rent	3.0	3.6	280*	90*	4.3	5.2	250*	80*
<u>Number of Rooms</u>								
1 - 5	5.4	6.6	300	100	6.0	7.2	230	90
6 or more	4.6	5.5	400*	130*	4.6	5.5	390*	130*
<u>Poverty Status</u>								
Below 125%	2.9	3.5	300*	100*	1.3	1.5	240**	80**
Above 125%	7.1	8.6	360	120	9.4	11.4	310	100
<u>Age</u>								
Under 60	6.6	8.0	360*	120*	7.8	9.4	320*	110*
60 and over	3.3	4.0	330*	100*	2.8	3.4	250*	80*
TOTAL	10.0	12.1	340	120	10.6	12.9	300	100

^{1/} See notes to Tables 1 and 2.

The 95% confidence interval for the average consumption in 1979-1980 of each group reported in this table is less than plus or minus 10% unless noted. The following symbols indicate ranges of the 95% confidence interval that exceed plus or minus 10%:

* between + 10% and + 20%

** between + 20% and + 35%

increase in costs, renters might not. Under price controls gas-heated rental units might command higher rents because of low heating costs. However, with decontrol these units would be likely to lose their economic advantage. This would cause rental prices to adjust with the gas cost increase divided between the owner and the renter according to local market conditions.

Many will be especially concerned about the effects of price increases on the aged and the poor. It is likely that in 1982 about 12.5 million households that heat with gas will be headed by individuals who are 60 years of age or older. In 1982, these households are estimated to pay an average \$450 for gas under current policies and \$590 with full decontrol. If current policies are continued, in 1982 the average bills for the elderly are projected to range across regions from a low of \$250 per household in the West to a high of \$640 in the North East. The increases caused by full decontrol in these regions are estimated to be about \$80 and \$160, respectively.

In 1982, about 7.9 million households that heat with gas will have incomes below 125% of the poverty level. Average gas expenditures for these households are forecast to increase by \$120, from \$420 to \$540 in 1982, because of full decontrol. The greatest average increase in the bill of poor households is likely to be in the North Central states, where the average bill may increase by \$170 from \$530 to \$700 in 1982.

B. Low Income Energy Assistance to Poor Households with Gas Heating

The Low Income Energy Assistance Program (LIEAP) helps many low income households pay their fuel bills. The Administration has requested that Congress appropriate \$1.4 billion for this program in 1982. (This would amount to about \$1.2 billion in 1980 dollars.) The Administration has proposed that the program be administered through block grants to the states.

If the states operate the block grant program in 1982 in the same manner that they operated the block grant component of LIEAP in 1981, families below 125% of the poverty level who live in households heated with gas are estimated to receive \$480 million in assistance in 1982.^{1/} If full decontrol were enacted in 1982, the states might increase the share of assistance to gas users by raising maximum payments allowed to gas users.

1/ The method used to estimate how Income Energy Assistance is described in Section V.

If current natural gas policies are continued, the total gas expenditures of poor households are estimated to be \$3.3 billion in 1982. If full decontrol takes place, it is estimated that the gas expenditures of poor households will increase to \$4.3 billion. Depending on which decontrol policy were in effect, the \$480 million of low income energy assistance would cover between 11 and 15 percent of these gas expenditures in 1982. The percent of total expenditures covered by low income energy assistance in each region ranges from 8% to 23% under current policies and from 6% to 18% with full decontrol. Table 4 shows the likely total expenditures and possible low income energy assistance by region.

Table 4

ESTIMATED TOTAL GAS EXPENDITURES OF THE POOR
AND LOW INCOME ENERGY ASSISTANCE IN 1982
(Millions of 1980 dollars)^{1/}

Region	Expenditures		Low Income Energy Assistance
	Current Policies	Full Decontrol	
North East	630	790	140*
North Central	1,480	1,930	210*
South	870	1,160	70**
West	300	410	70**
Total U.S.	3,290	4,280	480*

^{1/} Expenditures and assistance are for families who are below 125% of the poverty level and live in gas-heated houses.

The estimates of assistance are derived from 1980 and 1981 data. A different method of computing assistance, described in section V, would lead to higher estimates, which are indicated as follows:

- * The estimate may be 5% to 10% higher than on the table.
- ** The estimate may be 10% to 20% higher than on the table.

C. Comparison of the Costs of Heating with Gas, Fuel Oil, and Electricity

Consideration of alternative wellhead decontrol policies raises the question of how natural gas costs would compare to fuel oil and electricity costs under different decontrol policies. To compare fuel costs, it is not sufficient to compare total

household bills because fuels are used for different purposes. We chose to make the comparison for space heating.

To make a fair comparison of the costs of heating with different fuels, it is necessary to estimate the part of a household's total energy consumption that is used for space heating and to insure that the households under comparison are identical in all characteristics that affect space heating except for the fuel they use.

Regression models developed by the Energy Information Administration (EIA) enabled us both to estimate consumption for space heating and to specify that households be identical in all characteristics that affect heat consumption that are in the regression model except fuel type.^{1/} The regression models provided estimates of the energy consumption of families in single-family, detached houses during the 1978-1979 heating season.^{2/} We estimated the energy consumption of families in three different size houses in each of four geographic regions. (See Figure 1, above, for a map of the regions.)

The estimates of 1978-1979 heating season consumption were then used to estimate 1982 consumption by taking account of price increases and the price elasticity of demand for the fuels. The details of the methodology are reported in section VI of this appendix.

^{1/} The regression models were developed from data in the National Interim Energy Consumption Survey (NIECS). At least two variables that may affect consumption, insulation and thermostat setting, were not included in the regression models because of inadequate data in NIECS. There were no data in NIECS on thermostat setting, and the data on insulation were not sufficiently reliable to be used for the regression models. Descriptions of the regression models may be found in U.S. Department of Energy, Energy Information Administration, The National Interim Energy Consumption Survey: Exploring the Variability in Energy Consumption, DOE/EIA-0272, July, 1981, and The National Interim Energy Consumption Survey: Exploring the Variability in Energy Consumption-A Supplement, DOE/EIA-0272/S, October, 1981.

^{2/} Heating consumption was estimated for April, 1978, through March, 1979, which we refer to as the 1978-1979 heating season.

(1) Climate and Characteristics of Households

To estimate fuel consumption with the regression models, it was necessary to specify the number of heating degree days in the year and the characteristics of the household. To make a realistic comparison among fuels, we specified characteristics of households that were representative of households in one climate zone in each region in which more than one fuel is used for space heating. To ensure comparability, identical characteristics, except fuel type, were specified for each size house in a region. (Table 5 shows the characteristics of each household, and Figure 2 gives a map of climate zones in the United States.)

(2) Expenditures during the 1978-1979 Heating Season

To provide a benchmark for our analysis of heating costs in 1982, we estimated expenditures for space heating during the 1978-1979 heating season. We used prices reported in the Residential Energy Consumption Survey and consumption estimated with the regression models to calculate expenditures.

For all the households with the characteristics specified above, the estimates of the costs of heating with gas during the 1978-1979 heating season are less than the estimates of the cost of heating with fuel oil. The estimates of the costs of heating with electricity show that gas was less expensive than electricity in the South and was about as expensive as electricity in the West. The estimates of prices, consumption, and expenditures appear in Table 6.

(3) Expenditures in 1982 under Current Policies and with Full Decontrol

Because of expected price increases, average household consumption of all fuels is expected to be lower in 1982 than in the 1978-1979 heating season. Nevertheless, the drop in energy consumption will not fully offset the effect of rising prices on home heating bills. Between the 1978-1979 heating season and 1982, fuel oil bills of the types of households examined in this report are expected to rise by 35% to 41%, electricity bills by 5% to 6%, and natural gas bills under current policies by 9% to 19%. Under full decontrol natural gas bills are projected to rise by another 34 to 43 percentage points over 1978-1979 levels. The expenditure, consumption, and price estimates for 1982 appear in Table 7.^{1/}

^{1/} Percentage increases in expenditures calculated from Table 7 are slightly different from those reported in the text because of rounding.

Table 5

CHARACTERISTICS OF HOUSEHOLDS SELECTED FOR THE FUEL COST COMPARISON

Region, Climate Zone, and House Size ^{1/}	Heating Degree Days	Type of Heat- ing System	Year House Built	Bath- rooms ^{2/}	Doors and Windows	Storm Doors and Windows	Age of Respond- ent ^{3/}	Household Members	Family Income ^{4/}
<u>North East, Zone 3</u>									
4 rooms	5,200	Hot Water/Steam	1950-1959	1.0	12	10	52	2	14,000-16,000
6 rooms	5,400	Hot Water/Steam	1950-1959	1.0	17	15	52	3	16,000-20,000
8 rooms	5,500 ^{5/}	Hot Water/Steam	1939 or earlier	2.5	26	24	50	4	20,000-27,000
<u>North Central, Zone 2</u>									
4 rooms	6,900	Central Air	1950-1959	1.0	13	11	55	2	16,000-20,000
6 rooms	6,750	Central Air	1950-1959	1.0	18	16	50	4	20,000-27,000
8 rooms	6,600	Central Air	1950-1959	2.5	22	20	50	4	34,000 or more
<u>South, Zone 4</u>									
4 rooms	3,300	Central Air	1965-1969	1.0	13	7	55	2	11,000-14,000
6 rooms	3,400	Central Air	1965-1969	1.0	18	8	45	3	20,000-27,000
8 rooms	3,400	Central Air	1965-1969	2.5	20	12	50	3	34,000 or more
<u>West, Zones 2-3</u>									
4 rooms	5,400	Central Air	1940-1949	1.0	13	4	58	3	16,000-20,000
6 rooms	5,400	Central Air	1940-1949	1.0	17	6	58	3	20,000-27,000
8 rooms	5,400	Central Air	1965-1969	2.5	26	8	48	3	20,000-27,000

^{1/} All houses are single-family, detached dwellings. The climate zones are defined as follows:
 Zone 2 — 5,500 to 7,000 heating degree days (HDD)
 Zone 3 — 4,000 to 5,500 HDD
 Zones 2-3 in the West — 4,600 to 6,200 HDD
 Zone 4 — Less than 4,000 HDD and less than 2,000 cooling degree days.

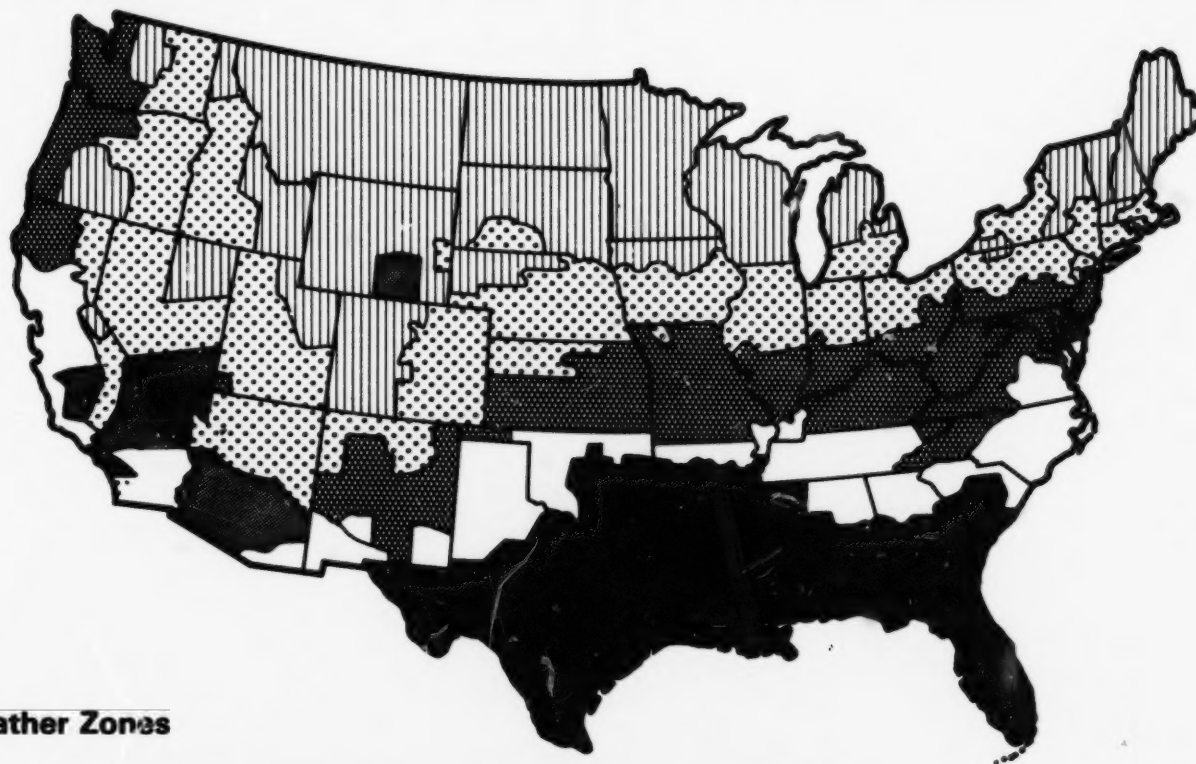
^{2/} Entries of 2.5 bathrooms refer to two full bathrooms and one half-bathroom.

^{3/} Age of respondent refers to the age of the person in the household who responded to the Residential Energy Consumption Survey. (Data from this survey were used to develop the regression model.)

^{4/} The family income reported in the table is in 1980 dollars. The amount used in the regression model was in 1977 dollars.

^{5/} The eight room houses in the North East tend to be located in relatively cold sections of climate zone 3. Hence, the number of heating degree days is high.

United States Weather Zone Map of Heating Degree Days (HDD) and Cooling Degree Days (CDD)



Weather Zones



Zone 1 Is Less Than 2,000 CDD and Greater Than 7,000 HDD.

Zone 2 Is Less Than 2,000 CDD and 5,500-7,000 HDD.

Zone 3 Is Less Than 2,000 CDD and 4,000-5,499 HDD.

Zone 4 Is Less Than 2,000 CDD and Less Than 4,000 HDD.

Zone 5 Is Greater Than 2,000 CDD and Less Than 4,000 HDD.

COMPARISON OF HOME HEATING EXPENDITURES,
1978-1979 HEATING SEASON
(Expenditures in 1980 dollars, consumption in mmBtu,
and prices in 1980 dollars per mmBtu)^{1/}

<u>House Size</u>	<u>Fuel Oil</u>	<u>Electricity</u>	<u>Natural Gas</u>	<u>Fuel Oil</u>	<u>Electricity</u>	<u>Natural Gas</u>
	<u>North East, Zone 3</u>			<u>South, Zone 4</u>		
<u>4 Rooms</u>						
Expenditure	590	- -	420	300	400	220
Consumption	120	- -	102	62	32	62
<u>6 Rooms</u>						
Expenditure	630	- -	500	300	500	260
Consumption	129	- -	121	68	40	74
<u>8 Rooms</u>						
Expenditure	940	- -	790	450	660	370
Consumption	191	- -	192	92	53	105
Price	4.92	- -	4.12	4.85	12.56	3.47
	<u>North Central, Zone 2 2/</u>			<u>West, Zone 2-3</u>		
<u>4 Rooms</u>						
Expenditure	450	- -	330	440	290	280
Consumption	95	- -	108	94	53	105
<u>6 Rooms</u>						
Expenditure	480	- -	390	480	320	330
Consumption	101	- -	126	102	59	124
<u>8 Rooms</u>						
Expenditure	720	- -	580	650	490	440
Consumption	152	- -	187	140	90	166
Price	4.71	- -	3.09	4.61	5.44	2.67

Table 6 (continued)

- 1/ See Table 5 for specifications of heating degree days and household characteristics and definitions of climate zones. Descriptions of the method used to estimate consumption appear in Section VI. All prices are from publications of the U.S. Department of Energy, Energy Information Administration. (The prices are different than those in the source because they have been converted to 1980 dollars per million Btu.)

Natural gas prices are average regional prices for single-family, detached dwellings from Residential Energy Consumption Survey: 1978-1980 Consumption and Expenditures--Part II; Regional Data, DOE/EIA-0262/2, May 1981, pp. 175-190.

Electricity prices are average regional prices for single-family, detached dwellings that use electricity for heating, but not air conditioning. Since prices paid during the cooling season tend to be higher than prices paid during the heating season, average prices of households that only heat with gas were used. The prices were taken from the source cited above, pp. 215-230.

Fuel oil prices are average regional prices from Residential Energy Consumption Survey: Consumption and Expenditures, April 1978 through March 1979, DOE/EIA-0207/5, July, 1980, pp. 74.

Estimates for electricity in the North East and North Central regions are omitted because relatively few homes are heated with electricity in those regions.

- 2/ Since zone 2 in the North Central states is colder than zone 3 in North East, one would expect the consumption of the households in the North Central states to exceed that of the households in the North East. However, the type of heating system used in the North Central states offset the effect of climate on the consumption of five of the six households examined. The North Eastern households in this comparison have steam or hot water heat, and the North Central households have central forced air heating systems. (This difference is consistent with the characteristics of households sampled in the Residential Energy Consumption Survey.) In the regression model, the steam and hot water systems are associated with considerably higher amounts of energy consumption than the central forced air systems.

Table 7

COMPARISON OF HOME HEATING EXPENDITURES
IN 1982, CURRENT POLICY AND FULL DECONTROL
(Expenditures in 1980 dollars, consumption in mmBtu,
and prices in 1980 dollars per mmBtu)^{1/}

House Size	Fuel Oil	Electricity	Natural Gas		Fuel Oil	Electricity	Natural Gas	
			Current Policy	Full Decontrol			Current Policy	Full Decontrol
	North East, Zone 3				South, Zone 4			
4 Rooms								
Expenditure	800	- -	470	590	410	420	230	310
Consumption	102	- -	91	85	52	31	57	52
6 Rooms								
Expenditure	860	- -	560	710	450	520	280	370
Consumption	110	- -	108	102	57	39	69	62
8 Rooms								
Expenditure	1,270	- -	890	1,120	620	690	400	520
Consumption	163	- -	172	161	78	51	97	88
Price	7.82	- -	5.20	6.96	7.91	13.52	4.10	5.94
	North Central, Zone 2				West, Zone 2-3			
4 Rooms								
Expenditure	620	- -	390	520	610	310	340	460
Consumption	79	- -	94	87	79	51	90	83
6 Rooms								
Expenditure	670	- -	460	600	660	340	390	540
Consumption	85	- -	109	102	85	57	106	97
8 Rooms								
Expenditure	1,000	- -	680	890	910	520	530	720
Consumption	128	- -	162	151	117	87	142	131
Price	7.85	- -	4.17	5.93	7.79	6.00	3.73 2/	5.50

^{1/} See Table 5 for the characteristics of these households during the 1978-1979 heating season and for definitions of climate zones. Descriptions of the method used to estimate consumption appear in section VI. Price forecasts are from the Divisions of Energy Deregulation and Analytical Services, U.S. Department of Energy.

^{2/} The price of natural gas in the West under current policy does not apply to areas that are heavily dependent upon imported gas from Canada.

If current policies are continued, in all the cases examined, natural gas is estimated to continue to have a substantial cost advantage over fuel oil in all regions and over electricity in the South. Natural gas is projected to be slightly more expensive than electricity in the West.

If full decontrol takes place in 1982, the gap between the costs of heating with natural gas and fuel oil in 1982 will narrow, but natural gas is projected to continue to be less expensive than fuel oil. In the South, natural gas also is estimated to be less expensive than electricity. In the cases examined in the West, natural gas is projected to become considerably more expensive than electricity.

III. EFFECTS OF "NEW-NEW" PHASED DECONTROL ON THE EXPENDITURES OF HOUSEHOLDS HEATED WITH GAS

This section describes the projected effects of the "New-New" phased decontrol policy on the gas bills of families that live in houses with gas heating. First, separate estimates are provided for various economic and demographic groups. Second, the benefits of Low Income Energy Assistance to the poor are estimated. Third, the costs of heating with gas are compared with the costs of heating with electricity and fuel oil.^{1/}

A. Effects of the "New-New" Phased Decontrol Policy on the Bills of Gas-Heated Households

In contrast to the full decontrol option, the "New-New" phased decontrol option involves a relatively small first year price increase followed by additional price increases in 1983, 1984, and 1985.

With the "New-New" phased decontrol option, average residential bills will rise \$40 from 1981 to 1982, another \$80 in 1983, \$70 in 1984, and \$40 in 1985.

The annual bill under phased decontrol would exceed the bill under current policy by \$20 in 1982, \$80 in 1983, and \$130 in 1984. The annual bill in 1985 would be about the same under current policies, under phased decontrol, and under full decontrol. (See Table 8.)

Under phased decontrol the increase in bills in 1982 is sufficiently small that there are few differences among demographic and economic groups. The principal differences are among regions. Households heated with gas in the Northeast and North Central regions are estimated to face increases averaging \$30 in 1982. Households in the South are likely to pay \$20 more under phased decontrol than under current policy, and households in the West are expected to pay \$10 more. These regional differences are reflected in estimated price increases for groups within regions. The estimates of national and regional increases in expenditures appear in Table 9.

^{1/} As noted in the previous section, consumers may make conservation investments or turn down their thermostats in order to save on gas costs. We have not attempted to estimate the amount of these non-gas costs because of difficulties of estimation.

Table 8

COMPARISON OF RESIDENTIAL NATURAL GAS BILLS UNDER
CURRENT POLICY AND PHASED DECONTROL (1981-1985)
(1980 dollars)^{1/}

<u>POLICY AND REGION</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>
<u>PHASED DECONTROL</u>					
North East	620*	670*	760*	830*	870*
North Central	560	620	730	810	860
South	330	360	420	460	520
West	280	310	380	420	450
Average U.S.	460	500	580	650	690
<u>CURRENT POLICY</u>					
North East	620*	640*	670*	690*	860*
North Central	560	590	620	650	850
South	330	340	350	360	520
West	280	300	320	330	450
Average U.S.	460	480	500	520	690
<u>DIFFERENCE BETWEEN PHASED DECONTROL AND CURRENT POLICY</u>					
North East	-	+ 30*	+ 90*	+140*	+ 10*
North Central	-	+ 30	+110	+160	+ 10
South	-	+ 20	+ 70	+100	-
West	-	+ 10	+ 60	+ 90	-
Average U.S.	-	+ 20	+ 80	+130	-

^{1/} The estimates in this table are based on data from (1) the Two-Market Model described in Appendix A, (2) the Residential Energy Consumption Survey (1979-1980), and (3) the American Gas Association. (See section IV below, for a description of the method used to estimate costs.)

Since the gas market model is not a probabilistic model and since the regional prices were not probabilistically estimated, confidence intervals for the average costs cannot be calculated. However, the accuracy of the estimates of the relative average expenditures of the groups reported will be affected mostly by sampling error in the Residential Energy Consumption Survey. The 95% confidence interval for the average consumption in 1979-1980 of each group reported in this table is less than plus or minus 10% unless noted.

* The range of the 95% confidence interval of gas consumption estimated in RECS is between $\pm 10\%$ and $\pm 20\%$.

Table 9

AVERAGE GAS COSTS OF GAS-HEATED HOUSEHOLDS IN 1982
UNDER CURRENT POLICY AND NEW-NEW PHASED DECONTROL
(1980 dollars)^{1/}

Group	United States		North East		North Central		South		West	
	Under Current Policy	Increase from Phased Decontrol in 1982	Under Current Policy	Increase from Phased Decontrol in 1982	Under Current Policy	Increase from Phased Decontrol in 1982	Under Current Policy	Increase from Phased Decontrol in 1982	Under Current Policy	Increase from Phased Decontrol in 1982
<u>Ownership Status</u>										
Own	530	20	750	30	620	30	370*	10*	340*	20*
Rent	390	10	490**	20**	500	30	280*	10*	250*	10*
<u>Number of Rooms</u>										
1 - 5	390	20	490*	20*	510	20	300	10	230	20
6 or more	580	20	810*	30*	690	30	400*	20*	390*	20*
<u>Poverty Status^{2/}</u>										
Below 125%	420	20	590*	30*	530*	30*	300*	20*	240*	10*
Above 125%	490	20	650	20	600	30	360	20	310	10
<u>Age</u>										
Under 60	490	20	640	30	590	30	360*	20*	320*	20*
60 and over	450	20	640*	20*	590*	30*	330*	10*	250*	10*
TOTAL	480	20	640*	30*	590	30	340	20	300	10

^{1/} See notes to Table 8. The 95% confidence interval for the average consumption in 1979-1980 of each group reported in this table is less than plus or minus 10% unless noted. The following symbols indicate ranges of the 95% confidence interval that exceed plus or minus 10%:

* between + 10% and + 20%

** between - 20% and - 35%

The number and percent of U.S. households in each group appear in Tables 2 and 3.

^{2/} Below 125% refers to households below 125% of the poverty level. Above 125% refers to all households above 125% of the poverty level.

B. Low Income Energy Assistance to Poor Households with Gas Heating

Families that are below 125% of the poverty level and live in houses heated with gas are likely to have a total gas expenditures in 1982 of \$3.4 billion with phased decontrol, compared to \$3.3 billion under current policies. As described in the analysis of full decontrol, if the states distribute low income energy assistance in 1982 in the same manner as they distributed the block grant component the Low Income Energy Assistance Program in 1981, gas users are likely to receive \$480 million in assistance. If phased decontrol were enacted in 1982, low income energy assistance would cover about 14% of the total expenditures of families that were below 125% of the poverty level and were living in gas-heated households. The percent of coverage would range from 8% to 22% depending on region. Table 10 lists total expenditures and likely assistance to families that are below 125% of the poverty level and that live in houses heated with gas.

Table 10

**ESTIMATED TOTAL GAS EXPENDITURES OF THE POOR
AND LOW INCOME ENERGY ASSISTANCE IN 1982
(Millions of 1980 dollars)^{1/}**

<u>Region</u>	<u>Expenditures</u>		<u>Low Income Energy Assistance</u>
	<u>Current Policies</u>	<u>Phased Decontrol</u>	
North East	630	660	140*
North Central	1,480	1,550	210*
South	870	910	70**
West	300	320	70**
Total U.S.	3,290	3,440	480*

^{1/} Expenditures and assistance are for families who are below 125% of the poverty level and live in gas-heated houses.

The estimates of assistance are derived from 1980 and 1981 data.

A different method of estimating assistance, described in section V, would lead to higher estimates:

- * The estimate may be 5% to 10 % higher than on the table.
- ** The estimate may be 10% to 20% higher than on the table.

C. Comparison of the Costs of Heating with Gas, Fuel Oil, and Electricity

With phased decontrol, in 1982 the projected costs of heating a home with gas would exceed the costs under current policies, but the increases would be considerably less than under full decontrol. Consequently, compared to full decontrol, in 1982 natural gas would maintain much more of its cost advantage over fuel oil in all regions and over electricity in the South. Under phased decontrol, the costs of heating with gas in the West in 1982 are projected to exceed the costs of heating with electricity, but the difference in costs is quite small compared to full decontrol. Table 11 shows the comparison of heating costs.

Although the costs of heating with natural gas would be less in 1982 under phased decontrol than under full decontrol, the differences in costs between the two policies would diminish during the phasing period. The costs of heating with natural gas would be about the same under the two policies in 1985.

Table 11

COMPARISON OF HOME HEATING EXPENDITURES
IN 1982, CURRENT POLICY AND PHASED DECONTROL
(Expenditures in 1980 dollars, consumption in mmBtu,
and prices in 1980 dollars per mmBtu) ^{1/}

House Size	Fuel Oil	Electricity	Natural Gas		Fuel Oil	Electricity	Natural Gas	
			Current Policy	Phased Decontrol			Current Policy	Phased Decontrol
	North East, Zone 3				South, Zone 4			
<u>4 Rooms</u>								
Expenditure	800	- -	470	510	410	420	230	250
Consumption	102	- -	91	88	52	31	57	55
<u>6 Rooms</u>								
Expenditure	860	- -	560	610	450	520	280	300
Consumption	110	- -	108	105	57	39	69	66
<u>8 Rooms</u>								
Expenditure	1,270	- -	890	960	620	690	400	430
Consumption	163	- -	108	166	78	51	97	94
Price	7.82	- -	5.20	5.76	7.91	13.52	4.10	4.54
	North Central, Zone 2				West, Zone 2-3			
<u>4 Rooms</u>								
Expenditure	620	- -	390	430	610	310	340	370
Consumption	79	- -	94	91	79	51	90	86
<u>6 Rooms</u>								
Expenditure	670	- -	460	500	660	340	390	430
Consumption	85	- -	109	105	85	57	106	101
<u>8 Rooms</u>								
Expenditure	1,000	- -	680	740	910	520	530	580
Consumption	128	- -	162	156	117	87	142	136
Price	7.85	- -	4.17	4.72	7.79	6.00	3.73 2/	4.29 2/

^{1/} See Table 5 for specifications of heating degree days and household characteristics and definitions of climate zones. Descriptions of the method used to estimate consumption appear in section VI of this appendix. Price forecasts are from the Divisions of Energy Deregulation and Analytical Services, U.S. Department of Energy.

^{2/} The prices of natural gas in the West do not apply to areas that are heavily dependent on Canadian gas imports.

IV. METHOD OF ESTIMATING AVERAGE RESIDENTIAL GAS COSTS

To estimate average residential gas costs in 1982, we (1) estimated total residential expenditures for gas, (2) divided the expenditures among demographic and economic groups according to each group's share of residential consumption from April, 1979, to March, 1980, and (3) estimated the average expenditure per household in each group. Below, each of these steps and the uncertainties associated with the estimates are described.

A. Estimate of Total Expenditures

Total residential expenditures on natural gas under current policies and under full decontrol are based on the estimates of residential prices and quantities in 1982 that were obtained from the Two-Market Model.^{1/} However, one adjustment was necessary. In the source of consumption data for the Two-Market Model, gas for residential uses appears in two customer sectors, the residential sector and the commercial sector. The commercial sector includes the consumption of residents of master-metered apartment buildings. For this analysis, the consumption by residents of master-metered apartment buildings was accounted for by increasing the residential sector consumption estimated by the model by 5.2%. This conforms to a similar adjustment made by the Energy Information Administration in the Annual Report to Congress/1980.

B. Estimate of the Aggregate Expenditures of Each Group

To estimate the aggregate expenditures for gas of each economic and demographic group, the total expenditures in each year under current policy and under full decontrol were divided among the groups according to forecasts of each group's share of residential consumption.

(1) Estimate of the Quantity Consumed by Each Group

To estimate consumption under current policies, it was assumed that each group's share of total residential consumption in each year would remain the same as the share from April, 1979, to March, 1980. The 1979-1980 shares were obtained from published and unpublished data from the Residential Energy Consumption Survey.^{2/}

^{1/} See Appendix A for a description of the modelling of the residential sector in the Two-Market Model.

^{2/} U.S. Department of Energy, Energy Information Administration, Residential Energy Consumption Survey: 1979-1980 Consumption and Expenditures, Part 1 and Part 2, April, 1981.

Because the Two-Market Model accounts for decreases in consumption owing to price increases, the average consumption per household is forecast to be less in 1982 and subsequent years than it was in 1979-1980.

To estimate the consumption of each group under full decontrol and phased decontrol, regional residential prices for gas were estimated along with the expected drop in consumption of each group that these prices would cause. The price elasticity of $-.25$, which is used in the Two-Market Model, was used to estimate the drop in consumption.

(2) Estimate of Regional Prices

To estimate regional gas prices in each year under current policies and under full decontrol, interstate and intrastate city-gate prices were obtained from the Two-Market Model. Actual 1979 distribution costs in each of the four Census regions were added to the appropriate interstate and intrastate prices. The distribution costs were derived from American Gas Association data by subtracting the average city-gate price per million Btu in each region from the average residential retail price per million Btu in each region.

The estimates of 1982 regional prices appear in Table 12.

Table 12

ESTIMATED RESIDENTIAL GAS PRICES BY REGION, 1982 (1980 dollars/mcf)

	<u>Natural Gas Policy</u>		
	<u>Current Policy</u>	<u>New-New Phased Policy</u>	<u>Full Decontrol</u>
North East	5.29	5.56	7.09
North Central	4.24	4.51	6.04
South	4.17	4.44	6.05
West	3.80	4.07	5.60

(3) Estimate of the Total Expenditures of Each Demographic and Economic Group

The total expenditures of each demographic and economic group were estimated by apportioning total residential expenditures according to each group's share of total residential consumption and the regional price under each policy.

C. Estimate of Average Expenditures of Households in Each Economic and Demographic Group

The average expenditure per household was obtained by estimating the number of households in each group and dividing this number into the total expenditure estimated for each group.

It was assumed that the total number of households in the U.S. and the number of households in each group would grow by 6.5 percent between 1979 and 1982, 1.8% in 1983, 1.7% in 1984, and 1.8% in 1985. These figures are intermediate values between series C and D of household growth rate forecasts of the Bureau of the Census^{1/} and are consistent with the growth rate used to estimate residential gas consumption in the Two-Market Model.

D. Uncertainty of the Estimates

The regional prices and quantities are rough estimates because they are not determined endogenously in the Two-Market Model. The estimates have been made separately because the model does not contain Census region detail.

As noted on the tables, some of the estimates are based on data from the Residential Energy Consumption Survey with wide confidence intervals. Any estimates followed by two asterisks should be regarded with caution.

^{1/} U.S. Bureau of the Census, Current Population Reports, Series P-25, No. 805, "Projections of the Number of Households and Families: 1979 to 1995" (U.S. Government Printing Office, Washington, D.C., 1979), p. 11.

V. METHOD OF ESTIMATING LOW INCOME ENERGY ASSISTANCE

This section of the appendix describes the method used and the assumptions made to estimate the amount of low income energy assistance the states would give in 1982 to families whose income is below 125% of the poverty level and who live in houses heated with gas.

The President has requested that Congress appropriate \$1.4 billion for the Low Income Energy Assistance Program (LIEAP) in 1982^{1/} and that all the funds be administered through block grants to the states.

The estimation of the amount of funds that gas users would receive under the Administration's program involved five steps:

- o estimating the amount of funds each state will receive
- o determining how the states might distribute the funds
- o estimating the amount of funds that would be used for administrative costs and given to families over 125% of the poverty level
- o estimating the share and amount of funds gas users in each state would receive
- o estimating the amount of funds that gas users in each region would receive.

A. Estimating the Amount of Funds Each State Will Receive

The Office of Family Assistance of the Department of Health and Human Services provided estimates of the amount of low income energy assistance that each state would receive in 1982 if Congress approves the Administration's request for a \$1.4 billion program. The estimates are based on funding formulas in the legislation authorizing the Low Income Energy Assistance Program.

B. Determining How the States Might Distribute the Funds

Low income energy assistance has been distributed to poor families through two major types of programs, automatic payment programs and application programs. Automatic payment programs distribute aid to families that participate in other assistance

^{1/} The appropriation request is reported in 1982 dollars. It would be \$1.2 billion in 1980 dollars.

programs, such as Aid for Dependent Children. Application programs require families to apply for energy assistance.

It is important to distinguish between funds distributed through automatic payment programs and those distributed through application programs because some application programs limit the amount a recipient can obtain according to the cost of heating fuel or according to the size of the total bill. Because gas is less expensive than other major heating fuels in most states, gas users are likely to qualify for less aid from application programs than users of other fuels. Unlike application programs, automatic payment programs generally give assistance without regard to fuel type or heating bill.

For this analysis, we assumed that each of the lower 48 states^{1/} would distribute all its aid according to the method it used to distribute its block grant assistance to most families during the first three quarters of the 1981 fiscal year.

Eight states aided most families through automatic payments in 1981. These states tend to have the largest numbers of recipients of assistance in the nation and are likely to receive about 32% of LIEAP funds to the lower 48 states in 1982. The remaining states and the District of Columbia aided most families through application programs.

At this time there is insufficient information to determine whether the states will make significant changes in their method of distributing aid in 1982.

C. Estimating the Amount of Funds Used for Administrative Costs and Assistance to Families above 125% of the Poverty Level

The states receiving block grants under the Low Income Energy Assistance Program are permitted to use 10% of the funds for administrative costs, 15% for weatherization, and 10% for other block grant programs. This analysis makes the simplifying assumptions that 10% of the funds will be used for administration and that the remainder will be used to help low income families pay their fuel bills.

The eligibility criteria for automatic payments from the Low Income Energy Assistance Program allow a small number of families that are above 125% of the poverty level to receive energy assistance. Participation in one of three assistance programs

^{1/} The four regions used in this analysis do not include Alaska and Hawaii because we do not have data from RECS on consumption in those states.

is often used to establish eligibility for low income energy assistance. The three programs are Supplemental Security Income, Aid for Dependent Children, and the Food Stamp program. According to the 1975 Survey of Income and Education, approximately 4% of the participants in the three programs were above 125% of the poverty level.^{1/} We have assumed that 4% of cash assistance will be distributed to families above the 125% level in 1982 and excluded this amount from our estimates of assistance.

D. Estimating the Share and Amount of Funds Gas Users in Each State Would Receive

We estimated the amount of 1982 funds each state would distribute to gas users. Different methods were used to estimate the distribution of funds by states that are expected to operate automatic payment programs and those that are expected to operate application programs.

(1) Application Programs

We assumed that gas users will receive funds from application programs in proportion to the share of households that received such assistance during the first three quarters of 1981, the most recent period for which data are available. Although it would be preferable to use the distribution of funds, as opposed to recipients, data on the distribution of funds according to heating fuel are not available.

The use of the proportion of recipients introduces an error into the estimate because gas users are likely to receive less assistance from application programs than users of other fuels because gas is less expensive. Thus, one would expect the share of assistance that gas users would receive to be lower than the proportion of gas users in the population of recipients as long as natural gas price controls are in effect. In view of this, we interpret our estimate of the share of aid that gas users might receive from application programs under current policies and phased decontrol policies as an upper bound.

We obtained the proportion of gas-heated households that received aid from application programs from the Department of Health and Human Services. We estimate that in 1982 these households will receive 38.1% of assistance from application programs in the North East, 54.1% in the North Central states, 32.9% in the South, and 58.1% in the West.

^{1/} This information was provided by the Office of Planning and Evaluation of the Department of Health and Human Services.

(2) Automatic Payment Programs

We assumed that the share of automatic payments that states will distribute to gas users will equal the share of cash payments for fuel bills given to gas users by the federal and state governments in each region in 1980. We have chosen 1980 because data on the distribution of cash payments are available from the Survey of Income and Program Participation conducted in that year. Unpublished data from that survey show that gas-heated households received 41.2% of cash payments in the North East, 76.6% in the North Central states, 34.4% in the South, and 44.0% in the West.

Using the regional distribution of aid to estimate the distribution within a state may involve error, because the distribution of gas users in the state may be different than the distribution of gas users in the region. To estimate the potential size and direction of the error, we estimated the amount of assistance gas users would receive in automatic payment states if the aid were distributed according to the proportion of poor families in each state that heated with gas.^{1/} For each of the regions, the estimates of aid based on the proportion of poor households heating with gas were higher than the estimates based on cash payments in 1980. If these alternate estimates of aid from cash payments were added to the estimates of aid from application programs, the estimates of total amount of aid to gas users would increase by 5% to 10% in the North East and North Central regions and by 10% to 20% in the South and West. Adding these percentages to the estimates in the report would give the upper limit of the amount of aid that gas users would receive under the current and phased decontrol policies.

E. Estimating the Amount of Funds Gas Users in Each Region Would Receive

The estimates of the aid that each state would give to gas users were added to calculate regional totals. The estimates of assistance are reported in Tables 4 and 10 of this appendix.

Table 13 shows the proportions of gas-heated households in the population below the 125% of poverty population from April, 1979 to March, 1980, the proportion of automatic payments gas heated households are projected to receive in 1982, and the proportion of households estimated to receive assistance through application programs in 1982.

^{1/} The proportions were provided by the Office of Planning and Evaluation at the Department of Health and Human Services and are based on the 1970 Census and the 1977 Annual Housing Survey.

Table 13

DISTRIBUTION OF GAS HEATED HOUSEHOLDS IN THE POOR
POPULATION AND RECEIPT OF ENERGY ASSISTANCE IN 1982^{1/}

	<u>% of Poor Households^{2/}</u>	<u>% of Aid from Automatic Payments^{3/}</u>	<u>% of Recipients of Aid from Application Programs^{4/}</u>
North East	38.5%	41.2%	38.1%
North Central	83.9%	76.6%	54.1%
South	50.0%	34.4%	32.9%
West	63.2%	44.0%	58.1%
Total U.S.	57.4%	47.3%	45.9%

^{1/} Poor population refers to those households with incomes below 125% of the poverty standard of living.

^{2/} The percent of poor households that are heated with gas is based on unpublished data from the 1979-1980 Residential Energy Consumption Survey.

^{3/} The percent of aid received through automatic payments in each region is based on unpublished data from the Survey of Income and Program Participation. The percent of cash payments to all poor gas users in the U.S. in 1980 was 51.8%. This is different than the 47.3% of automatic payments reported in the table because the distribution of automatic payment aid among the regions is expected to be different in 1982 than in 1980.

^{4/} The percent of recipients of aid from application programs is based on the number of recipients of aid from states that used such programs during the first three quarters of fiscal year 1981.

VI. METHOD OF ESTIMATING THE COSTS OF HEATING WITH THREE DIFFERENT FUELS

To make a fair comparison of the cost of heating with different fuels, it is necessary to (1) identify houses that are similar in all characteristics that affect heat consumption, (2) estimate the amount of the fuel that the household uses for space heating, as opposed to other uses, and (3) estimate the price per unit of the fuel that each house uses.

The Energy Information Administration (EIA) has developed regression models that can be used to estimate energy consumption of single-family, detached dwellings based on annual temperature and household characteristics. We used published and unpublished data from the Residential Energy Consumption Survey (RECS) to identify characteristics of households in regions and climate zones where at least two fuels are used for space heating by significant numbers of residents. Average fuel prices from April, 1978, through March, 1979, were taken from RECS, and forecasts 1982 prices were made. We used the EIA regression models to estimate consumption and expenditures in the 1978-1979 heating season.^{1/} Finally, we estimated consumption and expenditures in 1982 using our forecasts of prices and commonly used estimates of the price elasticity of demand for each fuel. Below, we discuss each of the steps in the analysis and the uncertainty of the estimates.

A. Using Regression Models to Estimate Energy Consumption for Space Heating

To compare heating bills, it is necessary to estimate the part of a household's total consumption of energy that is used for space heating. The Residential Energy Consumption Survey, which is the most recent source of data on household energy use, reports total household consumption of different fuels, but not the consumption for space heating.

We used regression models, which EIA developed, to estimate consumption for space heating in the 1978-1979 heating season. EIA's models relate total household energy consumption to characteristics, such as house size, climate, and number of

^{1/} In the discussion of heating costs, the 1978-1979 heating season refers to the period from April, 1978, through March, 1979.

appliances.^{1/} The models are based on data for one heating season from the 1978-1979 National Interim Energy Consumption Survey (NIECS).

The models were used to estimate fuel consumption for space heating by specifying that the household did not use the primary heating fuel for appliances, water heating, or air conditioning. This is a crude procedure because the variables for appliances, water heating, and air conditioning may capture characteristics of the household, such as affluence and the size of the family that may affect energy consumption for space heating. In addition, the intercept of the equation and other variables may capture energy consumption for running appliances.

To obtain unbiased estimates of consumption, it is important to specify household characteristics that are within the range of the variables used to develop the regression model. For example, one should not use the model to estimate fuel oil consumption in warm climates if there are no records of households heated with fuel oil in warm climates in the data set used to develop the model. By carefully reviewing special tabulations from RECS, we insured that the household characteristics specified were well within the range of observations used to develop the regression model.

^{1/} EIA estimated separate regression models for fuel oil, electricity, and natural gas consumption. The dependent variable in each equation is the total energy consumption of the household. The following independent variables appear separately or in interaction with other variables in one or more of the equations: heating degree days, number of rooms, number of bathrooms, type of heating system, year the house was built, number of doors and windows, number of storm doors and windows, age of respondent, number of residents, family income, and several variables related to water heating, air conditioning, appliances, and cooling degree days. As explained in the text, the appliance, air conditioning, and water heating variables were set to zero to isolate space heating consumption. The cooling degree day variable is only used in interaction with the air conditioning variable. A complete description of the models appears in "Exploring the Variability in Energy Consumption," cited above. The values of the independent variables used in our estimates appear in Table 5.

A final issue that arises when using the regression models is whether all the variable that affect consumption appear in the models. Two variables that might have affected consumption in the 1978-1979 heating season, thermostat setting and insulation, were omitted because there were no data in NIECS on thermostat settings and the data on insulation were not sufficiently reliable. It is likely that some of the variation in energy consumption associated with insulation is captured by the variable "year the house was built."

The price of fuel also does not appear as a variable in the model. Although variation in the price of each fuel, considered in conjunction with other variables in the models, may not have had a significant effect on a household's fuel consumption in the 1978 and 1979 heating season, there is strong reason to believe that increases in prices between March, 1979, and 1982 are likely to have a material effect on household characteristics and consumption. For example, price increases might lead the residents of a house to install more storm windows, have a furnace serviced, or turn down their thermostat. Consequently, we used the price elasticity of demand for each fuel to estimate the drop in consumption from March, 1979, to 1982. (The price elasticities used to estimate 1982 consumption are discussed below.)

B. Specification of Household Characteristics

Using published and unpublished tabulations of the RECS data, we identified climate zones in each region in which two or more fuels are widely used for space heating. Then, one climate zone in each region was selected for the fuel cost comparison. For each size house in the climate zone, we specified characteristics that were the same for each heating fuel and that fell within the range of household characteristics used in the development of each regression model. The region, climate zones, and household characteristics are listed in Table 5, above. Maps of the regions and climate zones appear in Figures 1 and 2.

Because our objective was to specify characteristics of households in climate zones where there is competition among heating fuels, the houses in this comparison are not necessarily representative of average or median houses that heat with each fuel in the region or climate zone. For example, in the West, since fuel oil tends to be used in the colder climates, the household characteristics specified tend to be representative of those found in colder climates in the region.

C. Estimates of Prices

(1) 1978-1979 Heating Season Prices

The prices used to estimate expenditures for the 1978-1979 heating season were based on average regional prices for large groups of households because the RECS sample was too small to estimate the prices paid by households with the characteristics specified for the fuel cost comparison. The RECS sample size is sufficient to estimate average prices paid by households in groups distinguished by about three characteristics. However, we specified ten characteristics for each household. The estimates for fuel oil during the 1978-1979 heating season are the average regional prices. The households examined in this study are likely to have paid a price very close to the average regional price, since there is little variation in fuel oil prices within regions.

In the case of gas and electricity, one cannot be sure that a household with given characteristics paid a price close to the average price in the region because gas and electricity prices vary according to (1) the cost of supplies to the local utility, (2) the local utility's rate structure, and (3) the quantity of gas or electricity the household uses. To approximate the price paid by gas users, we used average prices for single-family, detached dwellings.

The electricity prices used are the average prices paid by households that use electricity for heating, but not air conditioning. Households that use electricity for air conditioning were excluded because electricity is often more expensive in the cooling season than in the heating season. Including air conditioning costs in the calculation of average prices would exaggerate the cost of heating with electricity. Table 6, above, lists the prices used to estimate expenditures during the 1978-1979 heating season and the publications from which we obtained the prices.

(2) Estimates of Prices for 1982

The forecasts of 1982 prices for fuel oil are average regional prices estimated by the Division of Analytical Service of the Department of Energy. Electricity prices in 1982 are based on increases in average regional prices made by the Division of Analytical Services. The percentage increases over 1978-1979 average regional prices were applied to the 1978-1979 electricity prices used in this study. Regional natural gas prices are based on interstate and intrastate city-gate prices estimated in the natural gas market model and average 1979 distribution costs in each region. The 1982 fuel price projections are listed in Tables 7 and 11. The projections of gas prices in the West for the current and phased decontrol policies are not applicable to areas that rely heavily on Canadian gas because the prices of Canadian gas will exceed the regional average prices under either policy in 1982.

A significant element of uncertainty is introduced into these cost estimates by the difficulty of taking account of the different costs and rate structures of utilities that serve the types of households used for the fuel cost comparison.

D. Estimate of Consumption

Estimates of consumption for space heating during the 1978-1979 heating season were based on the results of EIA's regression models. The consumption and expenditure estimates for the 1978-1979 heating season appear in Table 6.

Price increases between March, 1979, and 1982 are likely to lead consumers to reduce their consumption of fuel in 1982. The estimates of 1982 consumption of each fuel were based on 1978-1979 consumption and prices, estimates of 1982 prices, and estimates of the price elasticity of demand for the fuel.

The following formula was used to estimate consumption after a price change.

$$Q_2 = Q_1 \left(\frac{P_2}{P_1} \right)^e$$

Q_2 = quantity consumed after the price change

Q_1 = quantity consumed before the price change

P_2 = price after the change

P_1 = price before the change

e = price elasticity of demand

Estimates of the elasticity of demand for fuel oil are more uncertain than estimates of the elasticities of other fuels. According to a review of price elasticities, there are no recent studies that have overcome all of the difficulties involved in estimating the elasticity of demand for fuel oil. To estimate the change in consumption of electricity from the 1979-1980 heating season to 1982, we used an elasticity -.35 because it is within the range of many of the existing estimates.^{1/}

The elasticities that were used to estimate natural gas consumption in 1982 were derived using the estimates of national average consumption and price in 1978-1979 from RECS and estimates of the implied average residential consumption and average

^{1/} Bohi, Douglas, Analyzing Demand Behavior: A Study of Energy Elasticities (Johns Hopkins Press for Resources for the Future, September, 1981).

residential price in 1982 from the Two-Market Model. The elasticity used to estimate changes in demand in response to decontrol in the Two-Market Model is $-.25$. This is well within the range of estimates of the price elasticity of demand for natural gas.^{1/}

E. Uncertainties About the Estimates

We have identified several sources of uncertainty in these estimates. First, it is difficult to precisely distinguish consumption for space heating from consumption for other uses. Second, the prices do not necessarily reflect the prices that local gas and electric utilities charge to households with the characteristics specified in this analysis. Third, estimates of the price elasticity of demand are highly uncertain.

Although there is considerable uncertainty associated with the absolute levels of consumption and expenditures of the classes of households discussed in this report, the relative consumption and expenditures appear plausible in the light of the patterns of consumption during the 1978-1979 heating season estimated with EIA's regression models. This can be seen by comparing Tables 6, 7, and 11.

^{1/} See Appendix A for a description of the Two-Market Model. The estimates of consumption of fuel oil, electricity, and natural gas in 1982 and the estimates of expenditures for these fuels appear in Tables 7 and 11.

VII. METHOD OF ESTIMATING THE TAXES AND AFTER-TAX INCOME OF PRODUCERS AND ROYALTY OWNERS

The natural gas decontrol study considers the change in producer income to be one measure of the distributional consequences of decontrol. The purpose of this section is to explain the method used to estimate producer income and the assumptions of the analysis.

To estimate the after-tax income of producers and royalty owners, the estimates of gross revenues and the producer surplus from the Two-Market Model were used to make rough estimates of (1) changes in the before-tax income of royalty owners and producers that would result from a change in policy, (2) the taxes on this income, and (3) the changes in the after-tax income of producers and royalty owners. These estimates are not precise and are calculated to make the broad point that a significant share of the "wealth transfer" from consumers is captured by state and Federal governments through taxes and royalty payments.^{1/}

Below, we discuss (1) the correspondence between the output of the Two-Market Model and the accounting concepts of before-tax income and (2) the calculation of royalty payments, taxes, and after-tax income.

A. Correspondence Between the Output of the Two-Market Model and Before-Tax Income

The Two-Market Model provides estimates of producer surplus and costs that are sufficient to estimate approximate changes in taxes and after-tax income that alternative natural gas decontrol policies would cause.

However, the estimates of the producer surplus and producer costs do not correspond precisely to accounting definitions of before-tax income and the costs that are deductible from income in a given year.

^{1/} The estimates of changes in government revenues that are involved in the estimation of after-tax revenues in this study have not been designed for and should not be used for budget or revenue estimates for two reasons. First, the increase in tax revenues from the gas industry is likely to be offset by decreases in tax revenues from other sectors of the economy, which are not accounted for in this analysis. Second, they do not achieve the degree precision ordinarily required for budget estimates.

Since the principal purpose of the decontrol analysis is to estimate economic costs and benefits, rather than accounting income and tax revenues, the Two-Market Model uses statistically estimated supply curves to estimate prices and quantities of gas sold under different policies and to estimate the producer surplus. A model based on accounting costs and income would give more direct estimates of taxes and after-tax income than the estimates in this report.

Below, we discuss the use of the producer surplus in the model and an adjustment of the model's estimate of the producer surplus for the part of royalty payments that are classified as producer costs in the model.

(1) Use of the Producer Surplus

The change in the producer surplus, with an adjustment for royalty payments described below, is likely to approximate the change in before-tax income because most of the change is from increased revenues from gas that would be produced under current policies. Hence, we can use the change in producer surplus to approximate changes in after-tax revenues.

Increases or decreases in the quantities of gas produced would affect deductions from income, such as intangible drilling costs, investment tax credits, and depreciation. Consequently, estimating the change in before-tax income from the change in the producer surplus owing to increases or decreases in production may involve errors. Fortunately, the changes in production quantities are small enough that errors in computing changes in taxable income from this production are likely to have little effect on the overall estimate. For example, full decontrol would lead to an increase in domestic production before 1985--an increase of 2.2 percent in 1982 and 6.0 percent in 1984. There would be little difference in production in 1985 because current policy provides for decontrol of substantial volumes of gas in that year. In 1990, domestic production would be 2.8 percent less under full decontrol than under current policies.

(2) Adjustment for Royalty Payments

The supply curve used in the Two-Market Model is the supply at the point of sale from the producer to the pipeline. It includes royalty payments and production taxes that are added to the producers' costs at a given price. These payments are often expressed as a fraction of the selling price or of the quantity of gas sold. In the Two-Market Model all royalty payments are treated as a fraction of the sales price when it is necessary to explicitly account for them. Thus, a fraction of the costs under the supply curve is a payment to royalty holders.

When calculating total changes in royalty payments between policies, an estimate of the change in royalty payments under the supply curve must be added to the estimate of change in royalty payments contained in the change in producer surplus.

B. Calculation of Changes in Income and Taxes

As explained above, a change in the producer surplus approximates a change in the income of producers before taxes and royalty payments. If the producer surplus increases, producers will not retain the entire increase. Their production taxes, payments to royalty owners, and income taxes will increase. Below, we discuss the method of estimating production taxes, royalty payments, income taxes, and after-tax income reported in the study.

(1) Production Taxes

An increase in revenues will lead to an increase in production taxes that are owed to state and local governments. In this report, the term production tax refers to any tax that is based on the quantity of gas produced or the revenues from production. These taxes include severance, conservation, occupation, and property taxes. We estimate that in 1979 production taxes equalled about 6.4 percent of the total market value of domestic production.^{1/}

In the Two-Market Model, production taxes are treated as a percentage of the revenue the producer receives from the sale of gas. Since an increase in the producer surplus is a part of the increase in the revenue that producers receive, state and local governments will receive a percentage of the producer surplus. We assume that state and local governments will continue to receive 6.4 percent of the market value of production until 1987 when the rate will increase to 6.9 percent because substantial quantities of Alaskan gas will enter the market.

^{1/} This is a weighted average of the production taxes received by the six largest gas producing states and Alaska in 1979. It is important to note that the production tax rate on total domestic production is lower than the rate on production that is subject to the tax, since production from federal lands on the outer continental shelf is exempt from state and local production taxes.

(2) Royalty Payments

Royalty payments are ordinarily a fraction of the market value of production. In 1979, the federal government received 4.9 percent of the market value of total domestic production from royalty payments on gas production on federal lands on shore and on the outer continental shelf.^{1/} In the same year, we estimate that the states received about 1.5 percent of the market value of U.S. domestic production and that private royalty owners received about 8.6 percent of the total market value of domestic production.^{2/}

In this analysis, we assume that, in the future, the federal government and private royalty owners will continue to receive the same fraction of market value as they did in 1979 and that state governments will receive 1.5 percent of market value until 1987, and 2.0 percent after 1987. The proportion of state revenues from royalty payments will increase in 1987 because Alaska will receive royalties from production in the state.

(3) Income Taxes

Producers and royalty owners will pay state and federal income taxes on any increase in income that is subject to tax. When calculating income taxes in this analysis, we do not account for the effects of reinvestment of earnings. Below, we discuss state income tax rates, federal income tax rates, the percentage depletion allowance, and reinvestment of earnings.

(a) State Income Tax Rates

The marginal state income tax rate before 1987 is estimated to be 4.2 percent. This is a weighted average of the marginal income tax rates of the six largest producing states and Alaska in 1979. The average is weighted by production quantities. We assumed that the state tax rate would increase to 4.5 percent in 1987 to reflect the effect of the increase in Alaskan production that is expected that year

^{1/} The percent of market value is based on royalty payments reported in the U.S. Geological Survey's "Federal and Indian Lands Oil and Gas Production, Royalty Income, and Related Statistics," June, 1980, and the total market value of gas is reported in the Energy Information Administration's publication "Natural Gas Production and Consumption, 1979."

^{2/} The state royalty rate is a weighted average of the royalty rates on gas of the six largest producing states and Alaska in 1979. The average is weighted by the market value of gas production in each state. The private royalty percentage is based on the assumption that the royalty rate to private land owners is 12.5 percent.

(b) Federal Income Tax Rate

The Federal income tax rate applied to the income of producers and royalty owners is 45 percent. This is weighted average of the marginal corporation income tax rate of 46 percent and a personal income tax rate of 40 percent on the earnings of partnerships and proprietorships.

(c) Percentage Depletion Allowance

Independent producers and royalty owners are permitted to use the percentage depletion allowance as a deduction from income. Taxpayers may claim percentage depletion on only a limited quantity of the oil and gas they produce. The percentage depletion allowance has been estimated to apply to 21 percent of oil and gas production^{1/} and to amount to 11.5 percent of oil volumes after royalties.^{2/}

Determining the amount of gas production that is eligible for the depletion allowance would require information about the amount of gas production of the independents, the extent to which the producers or royalty owners use up their allowed quantities on oil rather than gas production, and the amount of gas they produce that is eligible for the depletion allowance. Because this information is not available, we have assumed that the percentage depletion allowance will apply to all private royalty revenues (8.6% of all revenues) and 13 percent of the revenues of producers. This amounts to about 21 percent of gas production.

Current law provides that those who are eligible for percentage depletion may apply it to 18 percent of their production in 1982, 16 percent in 1983, and 15 percent in 1984. Thus, we estimate that, in 1982, about 21 percent of the change in producer and royalty revenues will be eligible for percentage depletion and that of this amount 18 percent will be claimed as a deduction on Federal income taxes.

^{1/} James C. Cox and Arthur W. Wright, "The Impact of the Tax Reduction Act of 1975 on the Petroleum Industry," Boston College Commercial and Industrial Law Review, 17 (June): 805-830.

^{2/} T. A. Guernsey, "A Financial Analysis Concerning Conventional Crude Oil and Natural Gas Exploration, Development, and Production Activities in the United States: 1959-1978," December 1980, p. 25.

The amount that a producer or royalty owner takes as a percentage depletion allowance is subject to minimum Federal tax of 10 percent.

(d) Reinvestment of Earnings

For most taxpayers, reinvestment of earnings would affect the timing of recognition of taxable income and increase taxable income. This analysis does not account for reinvestment of income.

If firms reinvest their before-tax earnings they become eligible for tax deductions and credits that would reduce their taxable income in the early years of a project. Some of the deductions taken in early years would increase their taxable income in later years. First, depending on the nature of the investment, the firms might be able to claim as much as ten percent of the investment as an investment tax credit during the first year of the project. Second, the firm might claim accelerated depreciation. Third, investors in some oil and gas development projects write off as much as 70 percent of the expenses as intangible drilling costs.

Rather than speculate about how the recipients of income would reinvest their earnings and benefit from reinvestment, we have calculated taxes and after-tax income without regard to the effects of reinvestment.

(4) After-Tax Income of Producers and Royalty Owners

Using the tax and royalty rates described above, we estimate the change in the producer surplus that producers and royalty owners would receive after taxes by subtracting Federal royalties, state royalties, production taxes, and income taxes from the estimates of the producer surplus.

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